COLLECTION AND MATURATION OF BROODSTOCK OF THE BLACK TIGER SHRIMP, *Penaeus monodon*

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ABSTRACT

Forty (40) broodstock of the black tiger shrimp, *Penaeus. monodon,* comprising of 16 males and 24 females were collected between November and December 2008 from three Nigerian Fishing Companies namely Karflex Fisheries Nigeria Limited, Honeywell Fisheries and ORC Nigeria Limited. The body weight ranged from 72.5 to 300g, total length from 24.0-34.0 cm and carapace length from 8.0-24.5cm. Abdominal length ranged from 10.3 - 16.0 cm, and telson length from 3.0-5.7cm. The stages of ovarian development ranged between 0 and 3.5 while the percentage of sperm carried by the females ranged from 0 to 100%. The broodstock were stocked in the maturation tanks in the Nigerian Institute for Oceanography and Marine Research shrimp hatchery and fed on squid to enhance gonadal development and maturation. Spawning of *P. monodon* was successfully carried out three times with an estimated production of one to two million nauplii at each spawning. Three hundred and twenty (320) post larvae (PL30) were stocked in concrete tanks for broodstock development. The post larvae have presently attained juvenile stage with average body weight of 16.01g. The availability of broodstock of *P. monodon* in Nigerian coastal waters will ensure successful hatchery production of post larvae for stocking of ponds leading to the development of shrimp farming.

INTRODUCTTION

Shrimp is the world's most important seafood commodity accounting for about 19 % of international trade in value terms. World shrimp production from fisheries and aquaculture has soared over the past 20 years to reach 4.65 million metric tonnes in 2003. Capture fisheries account for 3 million tonnes and are unlikely to increase, while aquaculture has seen a 10% per annum increase over the last decade (Banks, 2002). The family of Penaeid shrimps consists of approximately 110 species, ten of which are important for commercial culture. They occur naturally in the Indo-West-Pacific region, ranging from the eastern coast of Africa, the Arabian Peninsula, as far as South-East Asia, and the Sea of Japan. They also occur in eastern Australia, and a small number have colonized the Mediterranean Sea via the Suez Canal (FAO, 2002). Further invasive populations have become established in Hawaii and the Atlantic coast of the USA (Florida, Georgia and South Carolina). *P. monodon* is now available in Nigerian coastal waters and adapted to the environment (Ebonwu *et al.*, 2007). Juveniles of *P. monodon* occupy shallow estuarine waters sporadically entering rivers, while adults may be found in deeper waters up to 110 m especially over mud or sand bottoms (Grey et al., 1983).

The *Penaeus* species are shrimps that belong to the order of decapods (10 legs), which also includes the crabs, lobsters and crayfish. A main characteristic of the decapods is the fact that they have an exoskeleton which is shed during molting to allow further growth. The Black Tiger shrimp *Penaeus monodon* (Fabricius) is one of the most commercially important aquaculture shrimp species with production increasing from less than 1 000 tonnes in 1986 to 163, 000 tonnes in 1992 (Rosenberry, 1998). It tolerates wider salinity fluctuation, lends itself to domestication and has a well-established foreign market. The global annual average increase of farmed shrimp production rose to 1,087,111 tonnes in 2001 and valued at US $880,068,900 (FAO 2002). The Tiger shrimp ranked 20th by weight in terms of global aquaculture production by species and 1st by value (FAO. 1998). *P. monodon* is now estimated to account for 10% of the trawl caught shrimp in the Gulf of guinea (West Africa), even though it has only a recent introduction to the region. *P. monodon* is the largest of the penaeid species reaching 330 mm or more in body length, and exhibits the highest growth rate (Lee and Wickins, 1992) and suitable for intensive culture systems (Lightner, 1983; Johnson, 1989). Availability of broodstock of *P. monodon* for production of post larvae is a key factor in the development of shrimp farming in any country. Equally, the mode of collection and handling of the shrimp during trawling operations is also critical to their survival. Hence, broodstock collection from the wild is undertaken by trained scientists to minimize mortality and stress. This study investigated the feasibility of collection of live specimens of broodstock of Tiger shrimp from Nigerian coastal waters and subsequent spawning for hatchery production of post larvae.

LIFE – CYCLE OF TIGER SHRIMP

P. monodon are heterosexual animals with females attaining relatively larger size than males (Primavera, 1988). The males captured from the wild possess spermatozoa at 37 mm carapace length (CL) or about 35 g body weight (BW), and females at 47 mm CL or about 67.7g BW (Motoh, 1981). The females are highly fecund releasing over 248.000 to 811.000 eggs/spawn (Aquacop, 1979; Motoh, 1981). There are five stages in ovarian maturation: undeveloped, developing, nearly ripe; ripe; and spent (Primavera, 1980). A ripe ovary is large and lobed, 11-15% of BW, and at the widest point 0.5 the body width, also in the abdominal body. Unripe gonads are thread-like, and only located in the posterior body. A ripe gonad has a granular appearance and is gray-green. (Chen,1990). The adults spawn at sea. A mature male and recently molted female engage in a courting behavior, after which the male inserts sperm in the female sexual opening, the thelycum. The female can carry the sperm with her until she spawns the eggs or until she molts. When the eggs are released from the body, they pass the sperm and are fertilized. Females usually spawn within hours of fertilization, mostly at night.

The floating eggs, 200-300 micron in diameter, drift with the sea currents and develop into naupplii. This planktonic stage does not look like the adult shrimp; they are almost round in shape with featherlike arms protruding in all directions. *P monodon* has six nauplii stages followed by 3 zoea stages, 3 mysis stages and finally the post-larval stages. The postlarvae finally settle on the substrate in a coastal area and start a benthic life. The juveniles grow up near the coast, in mangrove areas or in more inland marshlands and estuaries. *P. monodon* juveniles prefer seagrass and weed beds (Chen,1990). Hatching occurs 12-15 hours after fertilization. The larvae (nauplii) are free swimming and resemble tiny aquatic spiders. This first stage in larval development does not feed but lives on its yolk reserve and passes rapidly through six moults. The next larval stages (protozoea, mysis and early post larvae (PL)) remain planktonic for some time and are carried towards the shore by tidal currents. Protozoea, which have feathery appendages and elongated bodies, moult three times and then metamorphose into the mysis stage. Mysis which have segmented bodies, eyestalk and tails characteristic of adult shrimp, also moult three times before metamorphosing into PL with similar characteristic to adult shrimp.

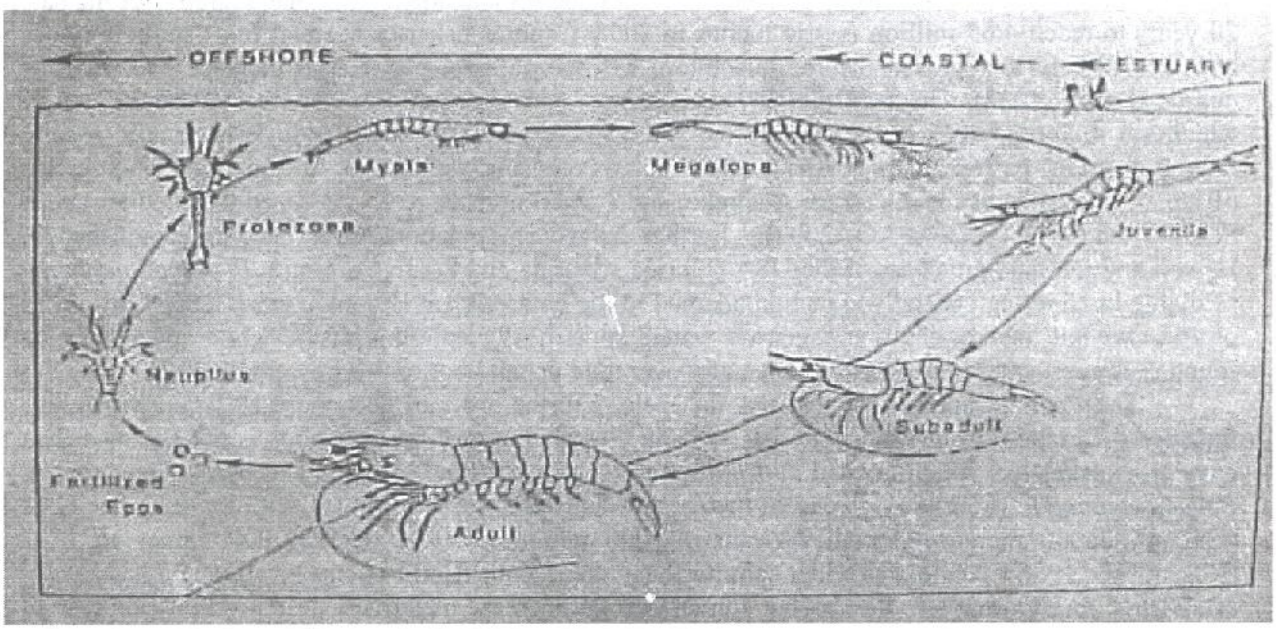

Fig 1. Life- cycle of Shrimp

COLLECTION OF SHRIMP BROODSTOCK

Live broodstock of *P. monodon* were collected from three Fishing Companies namely Honeywell, Karflex and ORC as well as during NIOMR sea trips on - board F/T Susainah, one of fishing trawlers belonging to Honeywell Fisheries Limited (Plate 1). Most of the samples of the Tiger shrimp were caught and collected in the night at depths of 10m, 20m, and 30m (Fig. 1). Activities performed during the sea trip included:

- Trawling for fish, shrimps and other invertebrates,
- Sampling for Benthos / Plankton,
- Water and sediment physico-chemistry,

- Microbiological sampling, other tasks are
- Collection of live samples *of Peaneus monodon*,

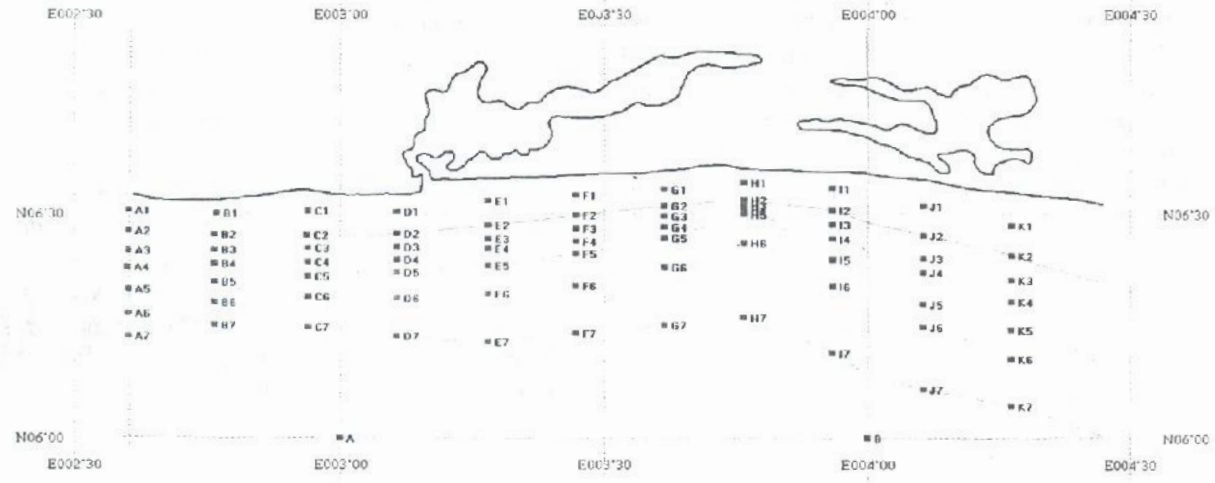

Fig. 1 Stations trawled for Broodstock collections

Three plastic containers were used for the broodstock collection and were equipped with either electric or battery operated aerators to keep the water constantly aerated on board and during transportation to NIOMR Shrimp hatchery (Kungvankij et al., 1985). The boat operateed on side trawl and each time the Captain launched the net in water, the boat will steam for thirty to forty minutes from one station to another before the nets are haulled up (Kungvankij et al., 1985). As soon as the net was hauled up, the caches are immediately released on the deck after pulling out the rope that closes the cod-end of the trawl net. All the catches were discharged on the deck and broodstock of *P.monodon* were quickly picked, examined and put in fresh, clean, and aerated seawater. Due to the long duration of the trip, live broodstock could not be collected and kept in captivity on board for a very long time; therefore, all the samples collected in the first three days of the trip were not kept alive. However, morphormetric characteristics i.e. total length, carapace length, abdominal length and telson length of dead samples were taken and stages of ovarian development determined. Immediately the vessel landed at the Kirikiri Jetty, the containers were discharged and quickly transferred to awaiting truck for final transportation to NIOMR hatchery. The body weights of broodstock of *P. monodon* collected from three fishing companies namely Karflex Fisheries Nigeria Limited, Honeywell Fisheries and ORC Nigeria Limited and stocked in the maturation tanks in the shrimp hatchery ranged from 72.5 to 300g (Plate 9). The total length (TL) ranged from 24.0-34.0 cm, Carpace length (CAL) 8.0-24.5cm, abdominal length (ADL) 10.3-16.0 cm, and Telson length (TEL) 3.0-5.7cm. Forty live specimens were collected comprising of 16 males and 24 females. The stage of egg development ranged between 0 and 3.5 % while the percentage of sperm carried by the females ranged from 0 to 50%.

SCREENING OF BROODSTOCK

Quarantine procedures were carried out before the breeders are introduced into the maturation tanks in preparation for spawning.Broodstock collected from the wild were screened and quarantined before stocking, Formalin (5%) was used for disinfection before transfer to the quarantine tanks. They were held in isolation until their health or disease status was ascertained. The breeders were later transferred to the maturation tanks for conditioning. Water quality parameters monitored in the broodstock tanks during acclimatization and maturation showed that salinity ranged from 30 -32.0 ppt, pH 7.5-7.6, alkalinity 120-144ppm, air temperature, 26.5-34.0 °C and water temperature 28.2 – 30.7 °C. Ammonia and nitrite levels ranged from 0-1.2 mg/l and 0-0.1mg/l, respectively

MATURATION / EYE-STALK ABLATION

Broodstock caught from the wild but still immature were fed with fresh diets (squid meat) to hasten maturation of their gonads. Hormones produced in the eyestalk control the development of the gonads in shrimps. Induction of maturation in the Tiger shrimp was by unilateral ablation of either the right or left eye of the female. Eye stalk ablation was carried out by cutting off ½ to 2/3 of the eye-stalk

with red-hot pincers The process of eyestalk ablation initializes gonadal development maturation begins. The ablated females were checked daily for their readiness to spawn.

SPAWNING AND LARVAL REARING

Gravid females in Stages 3 and above were selected from the maturation tanks and transferred to the spawning tank. The eggs were normally released at night and hatching occurred within 18 – 24 hours. The spawning tanks were covered with black tarpaulin (Plate 8). Spawning of *P. monodon* was successfully carried out three times with an estimated production of 1-2 million nauplii at each spawning. The nauplii were transferred to the nursery tanks after hatching and after yolk absorption, they were fed with the micro algae *Skeletonema* and *Chaetoceros* from Thailand. The algae were first bloomed in the laboratory and then transferred to the outdoor tanks for mass culture. Live Artemia nauplii were also given to the larvae from the mysis stage. The first post larvae of *P. monodon* produced in NIOMR shrimp hatchery weighed between 2.0 and 3.5g (Plate 9). The morphometric measurements showed that total length (TL) ranged from 3.5 - 6.5 cm, carapace length (CAL) 2.5-3.0 cm, abdominal length (ADL) 3.0-3.5 cm while telson length (TEL) was 1.0. Three hundred and twenty (320) post larvae (PL_{30}) were stocked in concrete tanks for broodstock development. The post larvae have presently attained juvenile stage with average body weight of 16.01g.

CHALLENGES

The major challenge encountered during this study was the high mortality rate of broodstock supplied from the fishing companies due to handling stress and power outages. Also landing of immature specimens was another drawback. The collection of *P.* monodon breeders from the wild is a common practice in many countries that are just starting shrimp farming. The broodstock are present in our territorial waters and gravid females and mature males are often landed. The major demerit of wild collection is that there is no genetic background information and pathogens may be transferred from the wild into the hatchery. Around Taiwan, the supply of *P. monodon* broodstock is between March and November (Chen,1990).. This period was found to be similar to the supply of the species from the Nigerian shrimp trawlers.

THE WAY FORWARD

The availability of broodstock of *P. monodon* in Nigerian territorial waters is a positive indication of a viable shrimp culture industry in Nigeria in the near future. Equally successful hatchery production of post larvae at NIOMR shrimp hatchery fis bold step towards development of shrimp farming in Nigeria. The thrust of future studies will centre on:

- Development of farm raised broodstock to avoid depletion of wild stocks.
- Establishment of earthen pond culture systems.
- Development of management protocols for broodstock production.
- Information dissemination to stakeholders on sustainable shrimp farming and other related environmental issues.
- Development of good quality local feeds for P. monodon broodstock.
- Shrimp genetic research
- Development of disease management protocols in broodstock rearing.
- Development of production certification procedures to meet the international export market.
- Capacity building.

REFERENCES

Aquacop, 1980. Reared Broodstock of Penaeus Monodon. Symp. Astal Aquaculture, January 12–18. Marine Biological Association of India, Cochin, India

Beard, T.W. and J.F. Wickins, 1980. Breeding of *Penaeus monodon* Fabricius in laboratory recirculation system. Aquaculture, 20: 79–89

Chanratchakool, P. 1993. Health Management in Shrimp Ponds. Aquatic Animal Health Research Institute, Bangkok, Thailand. 111 pp.

Chen, C.A., 1979. Preliminary report on the Gonadal Development and Induced Breeding of Penaeus monodon Fabricius. M.S. Thesis.Institute of Oceanography, National University Taipei, Taiwan

Chen, H.P., 1977.Report on maturation of *Penaeus monodon* Fabricius in captivity by eyestalk ablation and subsequent spawning and production of juveniles. Chin. Fish. Mon., 294: 3

Das, N.G., S.M.M. Sarwar and M.M. Parvez, 1997. Water quality management during gonodal maturation of Penaeus monodon Fabricius in a commercial hatchery at Cox's Bazar. Bangladesh J. Zool., 25: 65–70

Dore, I. And C. Frimodt. 1987. An Illustrated Guide To Shrimp Of The World. Osprey Books. Huntington, NY, U.S.A. 229 Pp.

FAO,2007.Improving Peneaus monodon hatchery practices.FAO Fisheries Technical paper,No 446,Rome,FAO.100pp

Heales, D. S., H. G. Polzin And D. J. Staples. 1985. Identification Of The Postlarvae Commercially Important Penaeus Species In Australia. Second Australian National Prawn Seminar, NPS2, Cleveland, Australia, Pp. 41-46

Holthuis, L. B. 1949. The Identity Of Penaeus Monodon Fabrc. Koninklijke Nederlandsche Akademie Van Wetenschappen, Vol, LII, No. 9, 1051-1057.

Marte, C. L. 1980. The Food And Feeding Habitat Of Penaeus Monodon Fabricius Collected From Makato River, Aklan, Philippines (Decapoda, Natantia). Custaceana 38(3): 225-236.

Motoh, H. 1981. Studies on the fisheries biology of the giant tiger prawn, *Penaeus monodon* in the Philippines. Technical Report, No. 7. Tigbauan, Iloilo: SEAFDEC Aquaculture Department, 128 Pp.

Motoh, H. And P. Buri. 1981. Identification Of Postlarvae Of The Genus Penaeus Appearing In Shore Waters. Researches On Crustacea 11: 3-11.

NACA/FAO. 2001. Asia diagnostic guide to aquatic animal diseases. FAO Fisheries Technical Paper, 402/2. FAO, Rome, Italy. 237 pp

Liao, I.C., T.I. Huang and K. Katsutani, 1969. A preliminary report on artificial propagation of *Penaeus monodon* Fabricius, Jr. Comm. Rural Reconstr. Fish Ser., 8: 67

Primavera, J. H. 1988. Maturation, Reproduction, and Broostock Technology. Chapter Two. Pp. 37-57 In: Biology And Culture Of Penaeus Monodon. Brackish water Aquaculture Information System, Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines.

Quinitio, E., D. de la Pena and F. Pascual, 1984. The use of substitute feeds in larval rearing of Penaeus monodon. Paper presented in the Int. Conf. on Aquaculture, Feb.,1983, Brigham Young University, Hawaii

Santiago, A.C., 1977. Successful spawning of cultured *Penaeus monodon* Fabricius after eyestalk ablation. Aquaculture, 11: 185–96

Solis, N. B. 1988. Biology and Ecology. Chapter One. Pp. 3-36. In: Biology And Culture Of Penaeus Monodon. Brackish water Aquaculture Information System, Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines.

Suthep,P.2008, Handout for Trainees at the demonstration and traninig on culture of Black Tiger Shrimp, *P. monodon.*

Yano I (1993) Ultraintensive culture and maturation in captivity of Penaeid shrimp. In CRC Handbook of Mariculture, 2nd Edition,Volume 1: Crustacean Aquaculture. McVey JP (ed) CRC Press, Boca Raton, pp 289-313